Heterogeneous Consumers, Demand Regimes, Monetary Policy Efficacy and Determinacy*

Giovanni Di Bartolomeo
giovanni.dibartolomeo@uniroma1.it
Department of Public Economics
University of Rome "La Sapienza"

Lorenza Rossi
lorenza.rossi@lu.unisi.ch
University of Rome "Tor Vergata" and
Istituto di Ricerche Economiche – IRE,
Università della Svizzera Italiana – USI, Lugano

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Abstract

The aim of this paper is to investigate both the efficacy and the stability properties of monetary policy rules in presence of heterogeneous consumers. We aim to underline the link between the well-known Taylor Principle and the demand-policy regimes, defined on the basis of the monetary policy transmission mechanism. By developing an analytical analysis, we show that the transmission mechanism plays a key role on monetary efficacy and equilibrium determinacy.

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1. Introduction

Campbell and Mankiw (1989, 1990, 1991) provide compelling evidence for the existence of heterogeneous consumers: households who can smooth consumption (*Savers* or Ricardian consumers) and agents whose current consumption equals current income (*Spenders* or Non-Ricardian consumers), which represent a strong violation of the permanent income theory.

Spenders' behavior can be interpreted in various ways. One can view their behavior as resulting from consumers who face binding borrowing constraints. Alternatively, myopic deviations from the assumption of fully rational expectations should be assumed (rule-of-thumb), i.e. consumers naively extrapolate their current income into the future, or weigh their current income too heavily when looking ahead to their future income because current income is the most salient piece of information available.[1]

The behavior of the Spenders is empirically important, with about one-fourth of income accruing to them in the United States (see Fuhrer, 2000).[2] With specific reference to monetary policy, Rotemberg and Woodford (1999) are among the first to estimate a simple output Euler equation, which is based on the simplest model of optimizing household behavior (there is no weight on past inflation).[3] Fuhrer (2000) obtains much better empirical results by enhancing the model of consumer behavior with Spenders and a habit formation process, which adds significant inertial output dynamics.[4] Muscatelli *et al.* (2003) stress that

[1] See Mankiw (2000) and references therein.

[2] Muscatelli *et al.* (2003) find an even larger proportion. They suggest that about 37% of consumers are Spenders, whilst 84% of total consumption in steady state is given by optimizing consumers. Spenders account for about 59% of total employment. Additional evidence is provided by Jappelli (1990), Shea (1995), Parker (1999), Souleles (1999), Fuhrer and Rudebusch (2003), and Ahmad (2004).

[3] Estrella and Fuhrer (1998) and Fuhrer (2000) show that this Euler equation provides a remarkably poor fit to the time series data on aggregate output.

[4] With a single equation for overall aggregate demand, it is not easy to infer the exact weight on expected future output and there are essentially no other

existence of Savers increases the variability of output and inflation. In their model automatic stabilizers based on taxation tend to offset the impact of Spenders without resulting counter-productive.

Recently, Spenders have been introduced, to study monetary policy, in a New Keynesian framework (Amato and Laubach, 2003; Galì *et al.*, 2003).[5] The presence of Spenders' behavior may alter dramatically the properties of these models and overturn some of the conventional results found in the literature.

Amato and Laubach (2003) explore the optimal monetary rule with rule-of thumb households and firms. By modeling consumers' rule-of-thumb behavior as a consumption habit, households' decisions today mimic yesterday's behavior of all agents, including optimizing agents. The authors discover that, while the monetary policy implications of rule-of-thumb firms are minimal, the interest rate is more sensitive to the presence of rule-of-thumb consumers; in fact, as their fraction increases higher inertial monetary policy is required.

By contrast, Galì *et al.* (2003) show how the Taylor principle becomes a too weak criterion for stability when the proportion of rule-of-thumb consumers is large. However, the presence of Spenders cannot in itself overturn the conventional result on the sufficiency of the Taylor principle. By contrast, in the case of forward-looking interest rate rules, they show that the conditions for a unique equilibrium are somewhat different from those in a contemporaneous one. In particular, they show that when the share of Spenders is sufficiently large it may not be possible to guarantee a (locally) unique equilibrium or, if it is possible, it may require that interest rates respond less than one-for-one to changes in expected inflation.

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available estimates with quarterly data. Fuhrer and Rudebusch (2003) face this problem.

[5] Moreover, Christiano *et al.* (2001) investigate the effects of a rule-of-thumb behavior in firms' decisions. Mankiw (2000) and Muscatelli *et al.* (2003) consider fiscal policy.

By using the Galì *et al.* (2003) framework, the aim of this paper is to investigate both the efficacy and the stability properties of monetary policy rules. Differently from previous works we tackle this issue from an analytical point of view rather than considering simulations/calibrations. By considering the problem analytically, we can discriminate between two different demand regimes (i.e. two IS-curves) characterized by different signs in the correlation between expected consumption growth and real interest rate. The introduction of Spenders into the DSGE New Keynesian model thus may explain the negative correlation between expected consumption growth and real interest rate sometimes found in the empirical literature. In fact, this correlation has been found to be low and sometimes negative across many of the industrialized countries (see Ahmad, 2004, Canzoneri *et al.* (2002)).

The existence of different regimes plays a very crucial role on the discussion about monetary policy efficacy and equilibrium determinacy. In particular, if the correlation between expected consumption growth and real interest rate is positive, monetary policy efficacy increases in the fraction of Spenders (as Amato and Laubach, 2003). A reverse result is obtained if the correlation between expected consumption growth and real interest rate is negative. Regarding determinacy, we find that in the case of a positive correlation, standard results hold, i.e. if monetary policy follows a standard Taylor rule and determinacy is always associated with the satisfaction of the Taylor principle. By contrast, if the correlation is negative, we find different requirements for stability conditional on the magnitude of the effects of interest rate changes on the real output. Hence the non-conventional results stressed by Galì *et al.* (2003) hold only if the correlation between expected consumption growth and real interest rate is negative.

The rest of the paper is organized as follows. Next section outlines our basic framework. Section 3 describes the two demand regimes implied by the presence of Spenders. Section 4 investigates the stability of the model under different monetary policy rules. Section 5 summarizes the monetary policy transmission mechanism. Section 6 concludes.

2. The Basic Framework[6]

We consider a simple New Keynesian model augmented by Non-Ricardian consumers (Galì *et al.*, 2003). In order to simplify the analysis and highlight the demand-side effects of Spenders' behavior we do not consider any capital accumulation process. We assume a continuum of infinitely-lived heterogeneous agents normalized to one. Savers are a fraction $1-\lambda$, they consume and accumulate wealth as in the standard setup. The remaining fraction agents λ is instead composed by Spenders who do not own any asset, cannot smooth consumption and thus consume all their current disposable income.

By solving the inter-temporal optimization problems of Savers and Spenders and aggregating, we obtain the following description of the demand side of the economy:

(1) $$c_t = -\left(1-\lambda\zeta_N\right)\left(i_t - E_t\pi_{t+1}\right) + E_t c_{t+1} - \lambda\zeta_N E_t \Delta\omega_{t+1},$$

(2) $$\omega_t = y_t + \upsilon n_t,$$

Equation (1) is the aggregate consumption function, it represents a modified version of the standard consumption Euler equation, where c_t is consumption, i_t is the nominal interest rate, π_t is the inflation rate. $\zeta^N = \left(1+\upsilon\right)\kappa\left(1+\kappa\right)^{-1}$ is the steady state share of Spenders' consumption. Our Euler equation differs from the standard one in which the last term of the right hand side of equation (1) is absent. This is due to the presence of the Savers, which establish a link between the demand for goods and the

[6] A large part of the model is rather standard (see e.g. Rotemberg and Woodford, 1997; or Woodford, 2003). Thus here the model is only described in its main equations. The demand side of the economy is derived in more detail in Appendix A since it plays a crucial rule. A technical appendix with a full-model derivation is available upon request:

real wage ω_t (see equation (2)). The variables y_t and n_t are respectively aggregate output and employment, while the parameter υ is the inverse of the Frisch labor supply elasticity.

The supply side of the economy is represented by a standard forward-looking Phillips curve:

(3) $\pi_t = \beta E_t \pi_{t+1} + k x_t + u_t$,

where $x_t = y_t - a_t$ is the output gap with respect to the flexible-price output and a_t and u_t are $AR(1)$ processes (representing respectively an exogenous technology and a cost push shock). More formally, the cost push shock is $u_t = \rho^u u_{t-1} + \tilde{u}_t$ with $\rho^u \in (0,1)$ and $\hat{u}_t \sim \text{i.i.d.}(0, \sigma_u)$.

By considering the log-linearized production function[7] $x_t = n_t$, aggregate consumption is written as

(4) $c_t = -(1-\lambda\zeta_N)(i_t - E_t\pi_{t+1}) + E_t c_{t+1} - \lambda\zeta_N(1+\upsilon)E_t\Delta x_{t+1} - \lambda\zeta_N \Delta a_{t+1}$.

Current consumption depends on real interest rate (because of the Euler inter-temporal substitution effect) and on the current output level with a income (output-gap growth) elasticity of consumption equal to $\lambda\zeta_N(1+\upsilon)$. If λ is equal to zero, i.e., all consumers may save, the income elasticity of consumption becomes nil and the standard Euler equation holds. Indeed, it is worth noticing that the income elasticity describes the effects of consumers' expenditure changes due to changes in real wage.

After some more algebra, equation (4) can finally be re-written as:

(5) $x_t = E_t x_{t+1} - \Omega(i_t - E_t\pi_{t+1}) + \Omega\Delta a_{t+1}$,

where $\Omega = \frac{1-\lambda\zeta_N}{1-(1+\upsilon)\lambda\zeta_N}$ is the *income monetary multiplier,* i.e. the semi-elasticity of the real output to the real interest rate.[8]

[7] The production function is $Y_t = A_t N_t$.

[8] It should be noticed that neither the share of Spenders' consumption nor the Frisch elasticity depends on the fraction of Spenders (see Appendix B).

3. Demand Regimes and Monetary Policy Efficacy

Equation (5) is similar to the standard one proposed by the New-Keynesian literature, the existence of Spenders however affects the impact of interest rate policy on aggregate demand from both a quantitative and a qualitative point of view. According to the sign of the income multiplier, equation (5) individuates two different regimes. If the income monetary multiplier is negative, increases in the real interest rates are expansionary, while interest rate cuts imply contractions – otherwise the standard transmission mechanism occurs (see e.g. Clarida, *et al.* 1999).

In other words, aggregate consumption (4) negatively depends on real interest rates and positively on current output by the income elasticity of consumption. This last is increasing in the share of Spenders, who are insensitive to interest rate movements, and in the extent to which labor supply is inelastic.[9] Hence, if Spenders are many and/or the inverse of the Frisch elasticity is high, the income elasticity can become greater than one and, as we can see in equation (5), the income monetary multiplier becomes negative, so that an increase in the interest rates causes an increase in output and aggregate consumption.

Summarizing, two regimes can emerge.

1. A standard regime holds if the income monetary multiplier is positive. Such a regime is dominated by the hypothesis of life-cycle permanent income and thus by the consumption smoothing theory.
2. An inverse regime holds if the income monetary multiplier is negative and it is dominated by the liquidity-constraint effect, where an increase in real interest rates is expansionary and interest rate cuts imply contractions since a large part of the consumers cannot access to financial markets and saving.

[9] In such a case, small variations in hours (and output) are associated to large variations in real wage and hence in the Spenders' consumption.

Formally, the two regimes depend on a threshold value of λ. The traditional regime holds for:[10]

$$(6) \qquad \lambda < \lambda^* = \frac{1}{\zeta_N (1+\upsilon)} = \frac{\kappa(1+\kappa)}{(\kappa+\theta)^2},$$

otherwise we are in the liquidity-constrained regime. The parameter $\theta = (\eta - 1)\eta^{-1} \in (0,1)$ indicates firms markup, where η is the elasticity of substitution across differentiated products.

For relatively low values of θ and high values of κ, the threshold value is greater than one ($\lambda^* > 1$). In such a case, only the standard regime occurs since $\lambda \in [0,1]$. For relatively high values of θ and low values of κ, the liquidity-constrained regime can emerge. In addition, if θ is greater than 0.5, λ^* is always smaller than one. Thus, in such a case, the liquidity-constraint regime always holds for a value of λ sufficiently great. Figure 1 describes the relationship between the two regimes and the parameters θ and κ.

Figure 1

Panel (a) illustrates the two regimes. The white area is the standard one, whereas the dark area is the liquidity-constrained regime. As claimed, for combinations of relatively low values of θ and high values of κ, i.e. points on the left of the black curve in panel (b) only the standard regime holds. The left curve represents the combinations of θ and κ corresponding to $\lambda^* = 1$ (the upper-bound). Flatter curves correspond to decreasing values of λ^*. The liquidity-constraint regime is then more likely to be observed for relative high values of θ and λ, and relative low values of κ.

In the standard regime the efficacy of monetary policy, which is measured by the size of the income monetary multiplier, is increasing in the fraction of rule of-thumb consumers. By contrast, in the liquidity-constrained

[10] The following condition implies that income elasticity of consumption is smaller than one. It is obtained by considering that the steady state value of N is $\theta(\kappa+\theta)^{-1}$ (see the Appendix B).

regime, its efficacy is decreasing in λ. Formally, $\partial|\Omega|/\partial\lambda > 0$ for $\lambda < \lambda^*$ while $\partial|\Omega|/\partial\lambda < 0$ for $\lambda > \lambda^*$.

The efficacy of monetary policy is represented in the figure 2, where the absolute value of income monetary multiplier, $|\Omega|$, vis-à-vis the fraction of Spenders, λ, is plotted.

Figure 2

Notice that without Non-Ricardian consumers, as $\lambda \to 0$, $\Omega \to -1$, thus elasticity of the real output to the real interest rate is minus one, i.e. as in the standard case with logarithmic utility. In such a case, a positive correlation between expected consumption growth and real interest rate is found. As long as λ increases the efficacy of monetary policy raises till $\Omega = +\infty$ (the income elasticity of consumption is equal to one). For $\lambda > \lambda^*$ the regime shifts to the liquidity-constrained one (where there is a negative correlation between expected consumption growth and real interest rate), an interest cut affects positively real output and the efficacy of monetary policy is decreasing in the fraction of Spenders, i.e. λ.[11]

It is finally worth noticing that the optimal response of monetary policy to a variation of the natural rate of output, which is equal to a technology shock (see equation (5)), depends on the demand regime. As usual, in the standard regime the central bank should respond by increasing the nominal interest rate of Ω to offset a unitary shock. By contrast in the liquidity constrained regime it has to reduce the nominal interest rate of an equal amount.

[11] Of course, for values of θ and κ implying $\lambda^* > 1$, only the first (decreasing) part of the figure is economically relevant.

4. Taylor Principle and Determinacy[12]

4.1. Exogenous Taylor rule

A description of the monetary authority behavior completes the model above-presented. Monetary policy can be described by an exogenous rule, which relates the interest rate to the other variables, or by an endogenous one, directly derived by the solution of an optimization problem, e.g. welfare maximization. One fundamental property which is requested for the monetary authority behavior is to support rational expectation equilibrium determinacy.

Let us start by considering an exogenous Taylor rule as the following:[13]

(7) $i_t = \alpha_1 \pi_t + \alpha_2 x_t$,

where α_1 and α_2 are both positive.

In the standard regime determinacy requires an *active* policy rule:

(8) $a_1 > 1 - \frac{1-\beta}{k} a_2$.

The above determinacy condition has a simple usual interpretation. A feedback rule satisfies the Taylor principle if in the event of a sustained increase in the inflation rate by one percentage point, the nominal interest rate will eventually be raised by more than one percentage point. Each percentage point of permanent increase in the inflation rate implies an increase in the long-run average output gap of $(1-\beta)k^{-1}$ percent. An exogenous Taylor rule thus conforms to the Taylor principle if and only if its coefficients satisfy $a_1 + (1-\beta)k^{-1}a_2 > 1$ (see, among others, Woodford, 2004).

[12] The proofs of determinacy conditions are provided in Appendix C.

[13] John Taylor has proposed that U.S. monetary policy in recent years can be described by an interest-rate feedback rule as that considered here (see, among others, Taylor (1993 and 1999) or Woodford (2004)).

In the liquidity-constrained regime, Ω is negative. To simply the exposition, we redefine it as $\bar{\Omega} = -\Omega$, which is a positive measure of monetary policy efficacy. Determinacy thus requires

(9) $$a_1 > \max\left\{1 - \frac{1-\beta}{k}a_2, \left(\frac{2}{\bar{\Omega}} - a_2\right)\frac{1+\beta}{k} - 1\right\}$$ or

(10) $$a_1 < \min\left\{\frac{1+\beta}{k} - \frac{a_2}{k}, 1 - \frac{1-\beta}{k}a_2, \left(\frac{2}{\bar{\Omega}} - a_2\right)\frac{1+\beta}{k} - 1\right\}$$

If $\bar{\Omega} > \frac{1+\beta}{k}$, the Taylor principle (9) holds, but the equilibrium is stable also if $a_1 < \min\left\{\frac{1+\beta}{k} - \frac{a_2}{k}, \left(\frac{2}{\bar{\Omega}} - a_2\right)\frac{1+\beta}{k} - 1\right\}$. By contrast, if $\bar{\Omega} < \frac{1+\beta}{k}$, $a_1 > \left(\frac{2}{\bar{\Omega}} - a_2\right)\frac{1+\beta}{k} - 1$ or $a_1 < \min\left\{\frac{1+\beta}{k} - \frac{a_2}{k}, 1 - \frac{1-\beta}{k}a_2\right\}$ is requested.

Summarizing, in the standard regime, the Taylor principle is the necessary and sufficient condition for determinacy. In the liquidity-constrained regime, we have to consider two cases.

a) If monetary policy has a relative high efficacy ($\bar{\Omega} > (1+\beta)k^{-1}$), the Taylor principle is only a sufficient condition for determinacy since also a (relatively) loose policy leads to the same result.
b) By contrast, if monetary policy has a relatively low efficacy ($\bar{\Omega} < (1+\beta)k^{-1}$), the Taylor principle does not leads to determinacy, a sufficient condition for determinacy requires a stronger reaction to inflation or, also in this case, a (relatively) loose policy.

The economic intuition of our results will be clearer after describing the case on an endogenous-Taylor rule and the monetary policy transmission mechanism in the liquidity-constrained regime.

4.2. Endogenous-Taylor rule (flexible-inflation targeting)

The monetary policy procedures consistent with loss minimization may be often represented as forward-looking relations between interest rate and expected inflation. Formally, in such a case, the central bank should follow an *optimal path* for the nominal interest rate satisfying:

(11) $i_t = \alpha_3 E\pi_{t+1}$.

where the coefficient α_3 is determined by the monetary policy regime where the central bank act and the parameters of the central bank loss. Equation (11) is usually derived from the solution of an optimization problem[14] and thus represents an endogenous (forward-looking) Taylor rule since a Taylor rule of the standard form can be easily derived from it. By using equation (3), the forward-looking Taylor rule can be re-written in the form of equation (7), where $\alpha_1 = \frac{1}{\beta}\alpha_3$ and $\alpha_2 = -\frac{1}{\beta}k\alpha_3$. Determinacy can be easily studied according to the lines of the previous sub-section. However, note that now either α_1 or α_2 is negative according to the sign of α_3.

In the standard regime, determinacy requires:

(12) $$a_3 \in \left(1, 1 + 2\frac{(1-\beta)}{k\Omega}\right).$$

Equation (12) is standard and nests the Taylor principle: monetary policy should respond more than one-to-one to increases in inflation, and should also not be too aggressive as noticed by Bernake and Woodford (1997).

In the liquidity-constrained regime, stability requires:

(13) $$a_3 \in \left(1 - \frac{2(\beta+1)}{\bar{\Omega}k}, 1\right).$$

Monetary policy has now to be conducted by a sort of inverted Taylor Principle. The central bank should respond less than one-to-one to increases in inflation. However, too loose monetary policies may also lead

[14] More in detail, equation (11) is derived from the so-called *flexible inflation targeting approach* (Svensson, 1999, 2003) under different monetary policy regimes (i.e. discretion, commitment or timeless perspective). It can be also seen as the results of the utility-based welfare maximization (Woodford, 2003: Chapter 6). However, to generalize our results to such a case one should show that the central bank's loss parameters (and thus α_3) are independent of the Spenders fraction. An analysis of the utility based welfare criterion is beyond the scope of the present paper thus we stick us to the interpretation of equation (11) as an optimal policy derived from an exogenous loss as e.g. Evans and Honkapohja (2005), i.e. *flexible inflation targeting approach*.

to indeterminacy. In particular, if monetary policy has relatively high effectiveness, $\bar{\Omega} > 2\frac{\beta+1}{k}$, indeterminacy may also derives from a loose positive reaction to expected inflation, i.e. $a_3 < 1 - \frac{2(\beta+1)}{\bar{\Omega}k}$. The rational of the inverse Taylor principle is straightforward. A positive non-fundamental shock in the expectations reduces the real interest rate; in the liquidity-constrained regime, if monetary policy is passive, it does not lead to the self-fulfillment of expectation since output falls. By contrast if monetary policy is set according to the Taylor principle, the real interest rate will increase as well as output and expectations will be self fulfilled.

The determinacy requirements in the liquidity-constrained regime can be also interpreted in the light of the recent debate on the central bank's conservativeness and market imperfections begun by Coricelli (2005). He shows that, in the New Keynesian DSGE models, determinacy requires a more conservative central banker as the degree of good market competition increases [15] As long as, the existence of rule-of-thumb consumers is interpreted as the result of non-competitive financial markets,[16] we find the same result of Coricelli (2005), but in a different context. In other words, market imperfections (financial market in our case) call for a less conservative central banker than under competitive ones.

Figure 3 synthesizes the above results in the parameter space, panel (a) ((b)) refers to a relatively low (high) fraction of Non-Ricardian consumers. In the standard regime, (white area) the Taylor Principle always holds. In the liquidity constraint regime we must distinguish between two type of monetary policy effectiveness: a relatively low effectiveness (dark area) and a relatively high one (light area). In the dark area, although an inverted Taylor principle holds, monetary policy leads to determinacy. By contrast,

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[15] This result contrasts with the finding in static context (see e.g. Coricelli, *et al.* 2000).

[16] See Mankiw (2000) for a brief discussion on the different interpretations about the assumption of rule-of-thumb consumers.

in the light area, even if an inverted Taylor principle still holds a too loose monetary policy leads to indeterminacy.

Figure 3

In the standard regime, if the policy rule is not active, a non-fundamental increase in expected inflation generates an increase in the current output gap and, by the current Phillips curve, inflation increases, validating the initial non-fundamental expectation. The Taylor principle is needed to guarantee determinacy since an active rule generates a fall in output gap and thus in actual inflation, contradicting initial expectations. By contrast, in a liquidity-constrained regime, if the policy rule is active, a non-fundamental increase in expected inflation generates an increase in the current output gap and an increase in inflation (by the Phillips curve), validating the initial non-fundamental expectation. Thus, in such a regime, the Taylor principle leads to indeterminacy, instead a passive policy rule is requested. In fact, if the central bank follows a passive policy rule, a non-fundamental increase in expected inflation is associated with a fall in the real interest rate, a fall in the output gap, and deflation, contradicting the initial expectation that are hence not self-fulfilling.

5. The Taylor Principle and the Monetary Policy Transmission

The implications of liquidity constraints on the Taylor Principle can be better understood by considering the monetary policy transmission mechanism. A key role in monetary transmission is in fact played by consumers' heterogeneity, which affects monetary policy via consumers' different choices.

For instance, consider a cost-push shock that increases inflation. Real interest rate decreases on impact. Without liquidity constraints, decreased interest rate will increase output-gap, and thus inflation. If monetary policy does not intervene we can expect self-full filling inflation. Given that prices increase real wage decreases, therefore Spenders' consumption falls and output declines. If the proportion of Spenders is high the output decline (via Spenders) more than compensates the output increase (via Savers), so that output gap will finally decline and a unique equilibrium is compatible in spite of a lower real rate. This means that the Taylor principle is not always a necessary condition for the determinacy. More importantly this monetary policy transmission mechanism justifies the positive sloped IS-curve which may hold for high proportion of Spenders. If instead the proportion of Savers is low, a lower real interest rate is not sufficient for equilibrium determinacy and the standard Taylor principle must be respected.

6. Conclusions

This paper introduces consumers' heterogeneity into a DSGE New Keynesian model. We find that the existence of consumers who cannot access to financial markets (Spenders) can explain the negative correlation between expected consumption growth and real interest rate often found in the empirical literature. More in detail, by an analytical investigation, we individuate two different demand-policy regimes characterized by different signs in the slope of the IS curve. In fact, a high proportion Spenders can be compatible with a unconventional positive-sloped IS-curve (liquidity-constrained regime).

By considering the liquidity-constrained agents, we find against conventional wisdom that if the slope of the IS is negative, monetary policy effectiveness increases in the fraction of Spenders. In fact, although a smaller fraction of Savers reduces the effects of interest rate policy on the inter-temporal allocation of consumption, the greater fraction of Spenders increases the effects of monetary policy by the variations in Spenders' consumption induced by real wage changes. By contrast, in the liquidity-constrained regime, the reverse effect holds.

The IS slope also affects the determinacy property of the rational expectation equilibrium. As long as a positive correlation between expected consumption growth and real interest rate is not observed standard results hold. Otherwise determinacy may be guaranteed by a passive monetary policy and the standard Taylor principle can be denied.

More in details, in the liquidity-constrained regime, results on determinacy can be summarized as follows.

1. If monetary policy is set according to a standard Taylor rule, the Taylor principle is only a sufficient condition for determinacy when monetary policy is relatively effective whereas a more aggressive central bank is needed if the monetary policy has a (relative) low efficacy. However, irrespectively of the policy efficacy, determinacy can also be achieved by a relative (loose) policy, which clearly does not satisfy the Taylor principle.
2. If the central bank supports an (optimal) dynamic relationship between output and expected inflation, determinacy requires that central bank should react less aggressively (not satisfying the Taylor principle), but not too loosely, since, in such a case, a non-fundamental increase in expected inflation needs an higher interest rate to be not self-fulfilling.

Finally, we want to stress that our results are closely related to the empirical verification of the relevance of the liquidity-constrained regime, i.e. negative correlation between expected consumption growth and real interest rate, which is however outside the scope of this paper. If the liquidity-constrained regime matters, determinacy needs to be studied with more attention and, in setting their policies, monetary authorities must take into account of the regime where they are since a good policy for a regime can be explosive in the another one. A possible additional factor explaining the explosion of bubbles in emerging markets could be related to attempt of managing the monetary policy according to rules designed for developed financial markets in economy where the financial market were not fully developed. This provocative reflection however is rather preliminary and need of more empirical verifications.

Appendix A – The demand side

Representative consumers are indexed by R (Ricardian) and N (Non-Ricardian), they maximize the following utility functions:

(a.1) $$E_t \sum_{i=0}^{\infty} \beta^i u\left(C_{t+i}^j, \frac{M_{t+i}^j}{P_{t+i}}, N_{t+i}^j, \phi^j \right) \quad j \in \{R, N\}$$

where $\beta \in (0,1)$ is the discount factor, C_t represents household consumption at time t, while $\frac{M_{t+i}}{P_{t+i}}, N_t$ are respectively, real money balances, and labor. ϕ^j is a binary variable such that when $j = R$, $\phi^R = 1$ and when $j = N$, $\phi^N = 0$. We assume the following logarithmic instantaneous utilities, $u(.) = \ln C_{t+i}^j + \kappa \ln\left(1 - N_{t+i}^j\right) + \phi^j \chi \ln\left(\frac{M_{t+i}^j}{P_{t+i}}\right)$ with $\chi > 0$ and $\kappa > 0$. By solving their optimization problems, consumers face the budget constraints: $C_t^j = \frac{W_t}{P_t} N_t^j + \phi^j \left[\Pi_t^j + TR_t^j - \frac{M_t^j - M_{t-1}^j}{P_t} - \frac{B_t^j - (1+i_{t-1})B_{t-1}^j}{P_t} \right]$, where W_t is the nominal wage at time t, Π_t is profit sharing, TR_t are Government lump-sum transfer Note that real wages are the only source of fluctuations of Non-Ricardian disposable income and therefore they are subject to a static budget constraint, while savers (Ricardian consumers) are the only ones facing a dynamic constraint. In fact, since spenders do not save they consume all their current income and the amount of money they hold at the end of period t is equal to zero.

By solving the Ricardian and Non-Ricardian representative consumers' maximization problems, we obtain the following first-order conditions:

(a.2) $$C_t^R = \left[\beta (1+i_t) P_t \right]^{-1} E_t \left[P_{t+1} C_{t+1}^R \right]$$

(a.3) $C_t^N = \frac{W_t}{P_t} N_t^N$

(a.4) $\left(P_t C_t^R\right)^{-1} = \beta E_t\left[P_{t+1} C_{t+1}^R\right]^{-1} + \chi P_t\left(M_t^R\right)^{-1}$

(a.5) $W_t P_t^{-1} = \kappa C_t^j\left(1 - N_t^j\right)^{-1} \qquad j \in \{R, N\}$

Equations (a.2) and (a.3) are the optimal consumption for Ricardian (i.e. inter-temporal stochastic consumption Euler equation) and Non-Ricardian consumers (who consume the whole labor income). Equation (a.3) is the optimal demand for real money balances for Ricardian consumers. Equation (a.4) is; the optimal condition for the labor supply. From equations (a.4) and (a.5), it is easy to find that Non-Ricardian consumers supply a fixed quantity of labor, i.e. $N_t^N = \frac{1}{1+\kappa}$.

The aggregate consumption and employment are

(a.6) $C_t = (1-\lambda) C_t^R + \lambda C_t^N$

(a.7) $N_t = (1-\lambda) N_t^R + \lambda N_t^N$

From equations (a.5) and (a.7), we obtain the wage aggregate supply:

(a.8) $C_t = \frac{1}{\kappa} \frac{W_t}{P_t}(1 - N_t)$

By log-linearizing equation (a.8) we obtain equation (2), recall that $Y_t = C_t$ in equilibrium. By log-linearizing equations (a.2) and (a.3) we find:

(a.10) $c_t = (1-\lambda)\zeta_R c_t^R + \lambda \zeta_N c_t^N$

(a.11) $c_t^R = -\left(i_i - E_t \pi_{t+1}\right) + E_t c_{t+1}^R$

(a.12) $c_t^N = w_t - p_t$

Solving equation (a.11) for c_t^R and using equations (a.10) and (a.12) we obtain equation (1).

Appendix B – Demand Regimes

This appendix shows the independence between the income monetary multiplier and the fraction of rule-of-thumb consumers. We need to relate the fraction of steady state fraction of Non-Ricardian consumption and the inverse Frisch elasticity only to deep parameters.

Regarding the former, from the demand side of the economy, i.e. equations (a.3) and (a.8), we obtain $\zeta^N = C^N C^{-1} = (1+\upsilon)\kappa(1+\kappa)^{-1}$, recall that Ricardian consumers supply a fixed amount of labor.

To find the steady state value of the employment, we introduce the supply side of the economy, but since it is rather standard we will briefly discuss it (a technical appendix is available upon request). As usual, we consider an economy composed by a continuum of firms (indexed by $z \in [0,1]$) producing differentiated intermediate goods with a constant return to scale technology $Y_t(z) = A_t N_t(z)$. Intermediate goods are used as inputs by a perfectly competitive final goods firm. In such a context, under flexible prices, all firms set their price equal to a constant markup over marginal cost, which, under the hypothesis of symmetric firms, is constant and given by

(b.1) $\theta = (\eta - 1)\eta^{-1}$.

Moreover, given the constant return to scale technology and the aggregate nature of shocks, real marginal costs are the same across the symmetric intermediate good producing firms. Accordingly, from the cost minimization, real marginal cost is:

(b.2) $\theta_t = A_t W_t P_t^{-1}$.

By equating equations (a.8) and (b.2), we obtain that in the steady state:

(b.3) $N = \theta(\kappa + \theta)^{-1}$,

which is independent of the fraction of Spenders.

Appendix C – Determinacy

Determinacy is studied by augmenting the log-linearized dynamic system (3)-(5) with a simple feedback rule (8), which also nests the simple case of the forward-looking Taylor rule of the form (12). From equations (8), (3), and (5), we obtain:[17]

$$\text{(c.1)}\quad \begin{bmatrix} 1 & \Omega \\ 0 & \beta \end{bmatrix} E_t \begin{bmatrix} y_{t+1} \\ \pi_{t+1} \end{bmatrix} = \begin{bmatrix} 1+\Omega a_2 & \Omega a_1 \\ -k & 1 \end{bmatrix} \begin{bmatrix} y_t \\ \pi_t \end{bmatrix}$$

Stability depends on the eigen-structure of the following matrix:

$$\text{(c.2)}\quad M = \begin{bmatrix} 1 & \Omega \\ 0 & \beta \end{bmatrix}^{-1} \begin{bmatrix} 1+\Omega a_2 & \Omega a_1 \\ -k & 1 \end{bmatrix} = \begin{bmatrix} 1+\Omega\left(a_2 + \dfrac{k}{\beta}\right) & \Omega\left(a_1 - \dfrac{1}{\beta}\right) \\ -\dfrac{k}{\beta} & \dfrac{1}{\beta} \end{bmatrix}$$

By indicating with $D(.)$ and $T(.)$ the determinant and trace operators, we have:

$$\text{(c.3)}\quad \begin{cases} D(M) = \beta^{-1} + \Omega\left(a_2 + k a_1\right)\beta^{-1} \\ T(M) = 1 + a_2\Omega + \left(1 + k\Omega\right)\beta^{-1} \end{cases}$$

The eigen-structure of matrix M is studied by following Woodford (2003: Appendices to Chapter 4). Since the analysis of the standard one does not differs from Woodford (2003), we only consider the liquidity-constrained regime. In this regime, determinacy requires either: *i)* $D(M) > 1$, i.e. $a_1 < \left[\left(1-\beta\right)\bar{\Omega}^{-1} - a_2\right]k^{-1}$, $D(M) \pm T(M) + 1 > 0$ or *ii)* $D(M_1) \pm T(M_1) + 1 < 0$. Being:

$$\text{(c.4)}\quad D(M) + T(M) + 1 = \left\{2\left(1+\beta\right) - \bar{\Omega}\left[\left(1+\beta\right)a_2 + \left(1+a_1\right)k\right]\right\}\beta^{-1}$$

$$\text{(c.5)}\quad D(M) - T(M) + 1 = -\bar{\Omega}\left[\left(1-\beta\right)a_2 + k\left(a_1 - 1\right)\right]\beta^{-1}$$

from equations (c.4) and (c.5) we derive conditions (10) and (11), respectively. Moreover, by considering a rule (12), it is easy to verify that

[17] In order to investigate the stability properties we do not need to look at the stochastic part that thus is omitted for the sake of brevity. We assume stationary disturbance processes.

$D(M)=\beta^{-1}>1,$ thus stability requires $D(M_1)\pm T(M_1)>-1$ and $D(M_1)\pm T(M_1)<-1$. By considering $\alpha_1=\beta^{-1}\alpha_3$ and $\alpha_2=-\beta^{-1}k\alpha_3$, it is easy to verify that $D(M_1)\pm T(M_1)<-1$ is never satisfied. By contrast, $D(M_1)\pm T(M_1)>-1$ requires condition (14).

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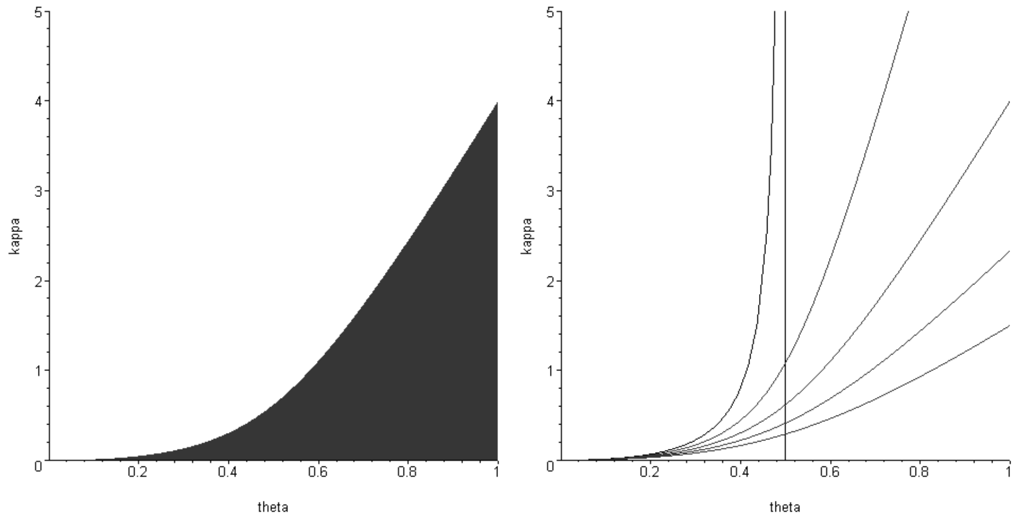
Figures



(a) (b)

Figure 1

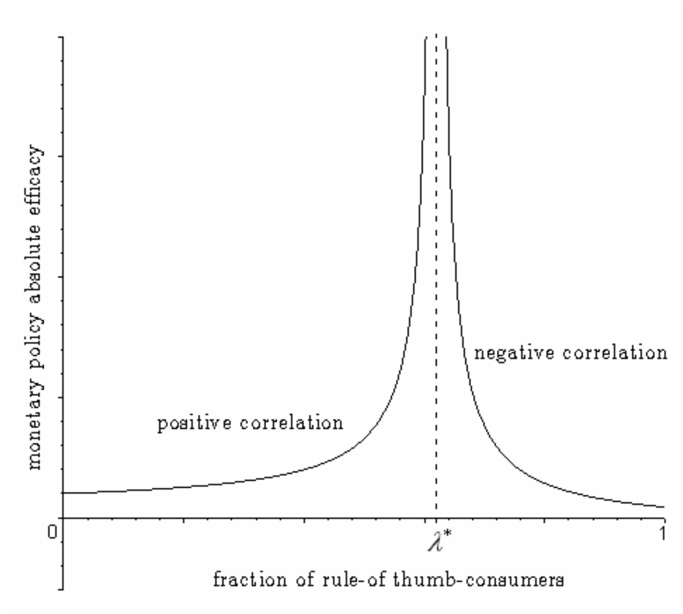
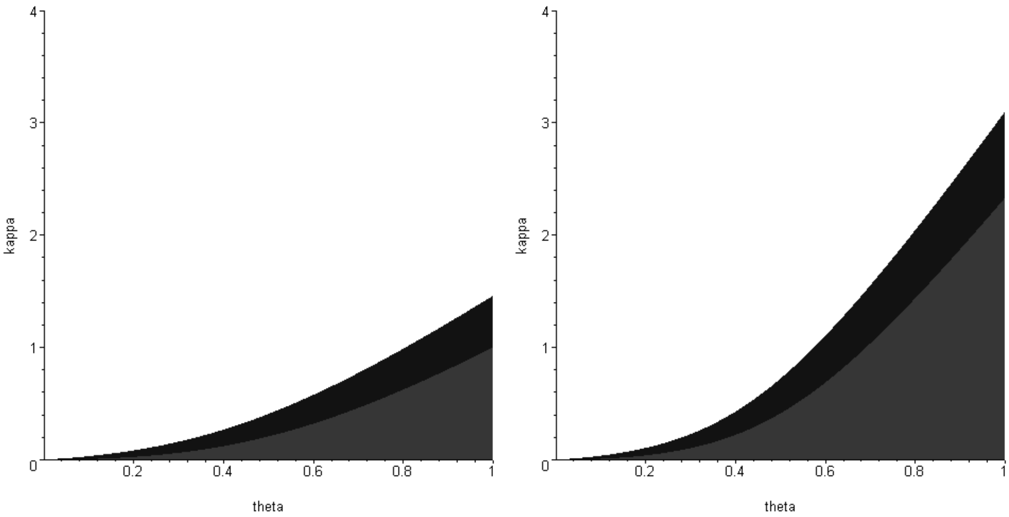


Figure 2



(a) (b)

Figure 3